New planktic foraminiferal data document Coniacian Age (88 Ma) for Laramide Orogeny onset and paleooceanography in southern Mex co

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ABSTRACT

As part of a larger project to assess the Mesozoic tectonostratigraphic evolution of the southern margin of the North America Plate, we report here new planktic foraminiferal data from northeastern Guerrero State, 120 km south of Mexico City. The study area is part of the southern arm of the Laramide fold-thrust belt of Mexico. Late Cretaceus flysch comprising the 2600 m thick Mexcala Formation record foredeep deposition associated with the initial local pulse of the

Laramide Orogeny. A total of 15 planktic foraminiferal species from 35 productive shale samples demonstrate that the Mexcala is assignable to the Coniacian to Santonian Age *Dicarinella concavata* biozone. Thus, local Laramide onset occurred during Coniacian time (88 Ma). Paleozoogeographic analysis based on the planktic foraminifers shows that a land barrier must have existed south and/or west of the study area, isolating the southern margin of the North America Plate from oceanic communication with the Conician-early Santonian Pacific Ocean.

INTRODUCTION

Since 1991, we have been mapping a 30 X 250 km, east-west, geological transect in northern Guerrero State, southern Mexico (Lang et al., 1996). Our overall objective is to improve understanding of the Mesozoic tectonostratigraphic evolution of the North America Plate near its southern margin in Mexico. Here we report new Late Cretaceus planktic foraminiferal data from the eastern end of the transect (Figure 1) that show that Laramide-age siliciclastic rocks of the Mexcala Formation ("fly ysch", according to Fries, 1960, and Ontiveros-Tarango, 1973) are assignable to the late Coniacian/early Santonian age *Dicarinella*

(Marginotruncana) concavata biozone (Pessagno, 1967; Caron, 1985). In addition to documenting an 88 Ma (Harland et al., 1982) Coniacian Age for onset of the Laramide Orogeny in southern Mexico, our faunas show that there was Coniacian/early Santonian oceanic communication with the Caribbean/Atlantic Ocean of the western Tethyan Realm. No planktic foraminiferal evidence for communication with the Pacific was found.

LOCATION AND GEOLOGIC SETTING

The study area (Figure 1), located 120 km south of Mexico City, corresponds to the eastern end of the geological transect mapped by Lang et al. (1996) in northern Guerrero State. It is covered by the Iguala, Tilzapotla, Huehuetlan, Atenango del Rio, and Temelac 1:50,000 topographic quadrangles of the Instituto National de Estadistica Geografia e Informatica of Mexico. Primary access is via a paved highway from Iguala, located 15 km west, that runs through Huitzuco, Atenango del Rio, and Papalutla. A mostly-paved tributary road runs north to Mitepec and Huachinantla, and continues on to Axochiapan, located 25 km north of the study area.

This region is part of the southern arm of the Sevier/Laramide fold-thrust belt of Mexico (Campa, 1985; Lang et al., 1996), and is characterized structurally by east-vergent folds and thrust faults (Figure 1). Late Cretaceus strata exposed in the area are assigned to the Morelos, Cuautla, and Mexcala formations of Fries (1960). According to Fries (1 960), Ontiveros-Tarango (1 *973),* and Lang et al. (1 996), siliciclastic strata of the Mexcala Formation are a flysch sequence that drowned the rudist platform and basin carbonates of the mid to Late Cretaceus Morelos and Cuautla formations, during the first pulse of the Laramide Orogeny in southern Mexico. The Mexcala is a foredeep sequence deposited east of an arc on the Late Cretaceus western margin of the North America Plate, in a tectonostratigraphic setting similar to the Soyatal and San Felipe formations of northern Mexico (Suter, 1984 and 1987) and the Niobrara Formation and equivalents of the U.S. western interior (McGookey et al., 1972).

No published reports of foraminifers are available for the study area. Fries (1 960) reported planktic foraminifers from one Mexcala sample collected at an unspecified locality west of the study area. He identified species of *Praeglobotruncana* and *Globotruncana* that have an age range from Albian through Maastrichtian.

METHODS

Eighty-one Mexcala samples were collected along the the Lang et al. (1 996) northern Guerrero transect. Because of the ubiquitously deep weathering of Mexcala shale, commonly dense vegetation cover, and typically difficult access, most samples came from road cut and arroyo exposures. In the laboratory, approximately 300 gm of crushed sample was boiled for 8 hours in a NaOH-buffered, Quarternary O detergent solution; wet sieved through nested 40 and 200 mesh screens; and dried. At least 200 foraminiferal specimens, or all present, were picked from the coarser than 115 mesh dry-sieved residue, as were other microfossils, and mounted on slides for identification. The finer fraction was examined, and biostratigraphically -diagnostic planktic specimens were also picked and identified.

The 44 samples collected west of the area covered by Figure 1 were barren of foraminifers. Thirty-five Mexcala shale samples collected at the 27 sampling sites identified on Figure 1 yielded planktic foraminifers. These samples came from four areas: 1) southeast of Huitzuco from a window of Mexcala below a thrust fault carrying the Morelos Formation; 2) east of Atenango del Rio from a syncline involving the Mexcala; 3) north and south of Mitepec from a syncline involving the Mexcala; and 4) northeast of Huachinantla from an isolated Mexcala exposure. Except for the sample from 4), whose stratigraphic position could not be determined precisely, all samples were projected into the Figure 2 composite Mexcala stratigraphic column, using available stratigraphic and structural data.

RESULTS

In the study area, the total thickness of the Mexcala Formation is approximately 2600 m (Figure 2). The formation can be divided informally into three member: 1) a lower, predominantly gray, calcareous shale sequence, approximately 1100 m thick; 2) a middle, predominantly variegated, calcareous sandstone and conglomerate interval, approximately 1100 m thick; and 3) an upper, predominantly gray, calcareous shale sequence, approximately 400 m thick. Thin, very-fine to fine grained sandstone intervals occur locally, as shown in Figure 2, in both of the shale sequences.

Foraminifers were only found in samples from the shale members. Two samples, barren of foraminifers, from the sandstone member contained charophyte oogonia. Most of the other samples contain ostracodes and benthic foraminifera. Benthic genera (not classified to species level) include *Spiroplectammina*, *Haplophragmoides,* *Trochammina*, *Ammobaculites*, *Gaudryina*, *Reophax,* *Anomalinoides*, *Gavelinella*, *Frondicularia*, *Globorotalites*, and *Lenticulina*.

The planktic content of our faunas ranges from 0% to 100%, with a mean value of 66%. The only fauna that did not contain planktic foraminifers was from a sample collected near the base of the upper shale.

We identified 15 planktic species (Figure 2): *Archaeoglobigerina blowi* Pessagno, *A. bosquensis* Pessagno, *A. cretacea* (d'Orbigny), *Dicarinella concavata* (Brotzen), *D. indica* (Jacob and Sastry), *D. paraconcavata* (Porthault), *Hastigerinoides subdigitata* (Carman), *Hedbergella subcretacea* (Tappan), *Heterohelix reussi* (Cushman), *Marginotruncana angusticarenata* (Gandolfi), *M. coronata* (Bolli), *M. renzi* (Gandolfi), *Rosita fornicata manurensis* (Gandolfi), *Whiteinella centennialensis* Frerichs, and *W. hessi* (Pessagno). All have been reported, describe and illustrated previously in Late Cretaceus faunas from the Gulf Coast region of Mexico and Texas (Pessagno, 1967; Longoria, 1984), from the U.S. western interior (Frerichs, 1979; Frerichs, 1989; Frerichs and Deiss, 1987; Frerichs and Gaskill, 1988), and/or from elsewhere outside North America (Caron, 1985).

DISCUSSION

We attribute the absence of foraminifers in Mexcala shale samples collected west of the area covered by Figure 1 to test dissolution resulting from dynamic metamorphism of the Mexcala Formation that led to sericite and chlorite formation as documented by Fries (1 960) in the Mexcala type locality, 30 km west of the study area. Apparently, during Late Cretaceus Laramide deformation, Mexcala strata were not buried as **deeply in the study area as they were to the west.**

The absence of foraminfers in samples collected from the middle sandstone and conglomerate of the Mexcala Formation in the study area is attributed to their non-marine environment of deposition. According to Ferrusquia-Villaf ranca et al. (1 993), these strata were deposited in terrestrial, probably deltaic, fluvial, and alluvial environments. Ferrusquia-Villaf ranca et al.'s (1 993) discovery of dinosaur tracks and our discovery of charophyte oogonia (fresh water plant fossils) in these strata support this interpretation. But contrary to Ferrusquia-Villaf ranca et al. (1 993), who assigned a Campanian-Maastrichtian age to the dinosaur tracks based on the occurrence of Acteonellid gastropod fossils, our planktic foraminifers from superjacent Mexcala shale preclude an age younger than Santonian.

The zonation schemes proposed by Pessagno (1967) and Longoria (1984) for Late Cretaceus strata exposed in the Gulf Coast region of central Mexico (Figure 1) are applicable to our faunas, as is the global scheme of Caron (1985). The presence of the index species *D. concavata* associated with *M. augusticarenata*, *R. fornicata* s. l., *M. renzi*, and *A. blowi* is clear evidence for assignment of most of our faunas to Pessagno's (1 967) *Dicarinella (Marginotruncana) concavata* subzone, now considered to have a late Coniacian to early Santonian range (Caron, 1985). This subzone is equivalent in planktic faunal content and age to Longoria's (1 984) K-22 and K-23 biozones. The first appearance of *H. subdigitata* with *D. concavata* in our second highest sample suggests that this sample is early Santonian Age (Figure 2) (Caron, 1985, fig. 11).

Our faunas are also amenable to paleozoogeographic analysis. According to Douglas (1 972) and Caron (1985), diverse Coniacian/ Santonian faunas similar to ours, consisting of 10 or more planktic species with abundant *D. concavata*, are characteristic of deep water marine environments of the Caribbean and Tethyan realms. The absence of the Pacific Ocean planktic species *M. cachensis* and *H. kingi* and the rare occurrence of *M. coronata* in only one sample, as well as the presence of the Gulf Coast species *M. renzi* and *R. fornicata s./.* in most of our samples, argue for no oceanic communication with the Pacific Ocean (Douglas, 1972). A land barrier must have existed west and/or south of the study area during Coniacian/early Santonian time. This paleozoogeographic interpretation is consistent with Ross and Scotese's (1988) Late Cretaceus reconstruction of the configuration of the Pacific and Caribbean plates and Chortis block near the southern margin of the North America Plate.

CONCLUSIONS

In northeastern Guerrero State, southern Mexico, strata of the Mexcala Formation record foredeep sedimentation during the initial phase of the Laramide orogeny near the southern margin of the North America Plate. The Mexcala is over 2600 m thick and is comprised of informal lower and upper marine basinal shale members and a middle deltaic sandstone/conglomerate member. Diverse planktic foraminiferal faunas from the shale members, consisting of 15 species, are assigned to the

Dicarinella concavata biozone of Pessagno (1969), and thus demonstrate a Coniacian-Santonian Age for these strata (Caron, 1985). The Coniacian Age (88 Ma) of the lower shale dates the local onset of the Laramide orogeny. The Coniacian-Santonian stage boundary occurs near the top of the upper shale member.

Paleozoogeographic assessment of the faunas, using criteria of Douglas (1972) and Caron (1985), shows that oceanic communication was with the Caribbean. There is no planktic foraminiferal evidence for communication with the Pacific. Thus, during Coniacian-Santonian time a land barrier must have existed west and/or south of the northeastern **Guerrero study area, near the southern margin of the North America Plate.**

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Faunal slides are stored at the University of Wyoming Micropaleontology Laboratory. Mike Abrams reviewed the manuscript.

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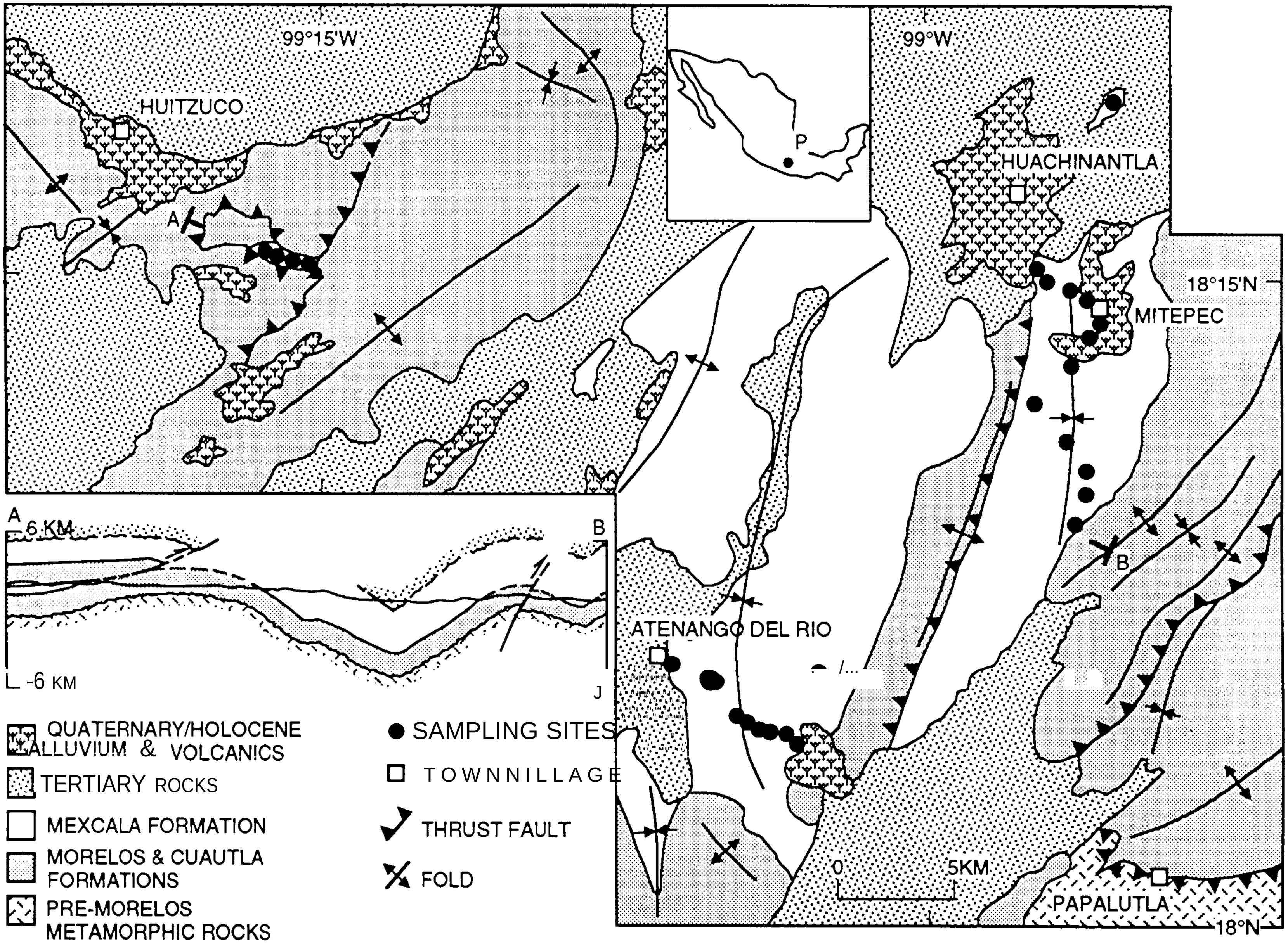
FIGURE CAPTIONS

Figure 1. Simplified geologic map and cross section of the northeastern Guerrero study area showing Laramide structures (after Lang et al., 1996) and Mexcala sampling sites. Inset map of Mexico shows location of study area (dot) in southern Mexico, and the Gulf Coast region of Mexico (P) where Pessagno (1967) and Longoria (1984) developed their planktic foraminiferal zonation schemes.

Figure 2. Composite stratigraphic column, range chart for planktic foraminifers, and age of the Mexcala Formation in the study area.



LANG & FRERICHS FIG. 1

& FRERICHS FIG. 2